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An In-Depth Look:

ACUTE ABDOMEN

Acute Abdomen: Diagnosis*

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ABSTRACT:

The term *acute abdomen* is defined as the sudden onset of abdominal discomfort or pain. Clinical signs that usually accompany this condition include abdominal distention, anorexia, lethargy, generalized gastrointestinal signs (e.g., vomiting, diarrhea), and various stages of shock. Clinical pathology, radiology, ultrasonography, and methods of collecting free abdominal effusion are often necessary to promptly diagnose and treat the disease processes that lead to visceral pain. If the underlying cause is left untreated, death could result.

Acute abdomen (i.e., sudden onset of abdominal pain) is commonly seen in veterinary medicine. Because acute abdomen can be a clinical manifestation of myriad conditions, cases of acute abdomen can often be diagnostic challenges. The goals of this article are to review patient signalment, history, and physical examination as well as the diagnostic steps required to accurately assess and treat patients with acute abdomen. Specific attention has been given to the processes of radiographic and ultrasonographic imaging, clinical pathology, and diagnostic peritoneal lavage.

PATHOPHYSIOLOGY OF PAIN

Abdominal pain originates via stimulation of type C and A nerve fibers located in the capsules of abdominal viscera, parietal peritoneum, and mesentery. The terminal ends of these fibers receive activating stimuli when they are stretched. Stretching can occur during food bloat, gastric dilatation–volvulus (GDV), obstructive ileus, and swelling or hemorrhage of solid organs. Nociceptive stimulation also occurs with ischemic insults such as thromboembolic episodes or significant trauma. Inflammatory mediators (e.g., substance P, histamine, serotonin) released during such events can cause irritation and pain.[1]

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Differential Diagnosis of Acute Abdomen

Gastrointestinal
- Infectious enteritis
  —Parvovirus
  —Panleukopenia
  —Parasites
- Hemorrhagic gastroenteritis
- Obstruction
  —Neoplasia
  —Foreign body
  —Intussusception
  —Bowel incarceration
- GDV
- Gastric ulcer
- Gastric perforation
- Mesenteric volvulus
- Obstipation

Hepatobiliary
- Hepatitis (infectious, toxic)
- Hepatic neoplasia
- Hepatic abscess
- Cholangiohepatitis
- Biliary tree rupture
- Biliary obstruction

Pancreatic
- Pancreatic neoplasia
- Pancreatic abscess
- Pancreatitis

Splenic
- Splenic torsion
- Splenic neoplasia
- Splenic trauma

Urogenital
- Trauma
- Nephritis
- Pyelonephritis
- Ureteral (obstruction or rupture)
- Urethral (obstruction or rupture)
- Bladder rupture
- Bladder neoplasia
- Prostatitis
- Prostatic abscess
- Pyometra
- Metritis
- Torsion (uterine or testicular)

Peritoneal
- Peritonitis
  —Chemical
  —Septic

Miscellaneous
- Abdominal wall hernia
- Spinal pain

Abdominal pain can be separated into two categories—visceral and somatic. Splanchnic fibers of solid organs are responsible for carrying afferent impulses toward the sympathetic chain and up the spinal cord.[2] The resultant sensation is dull, generalized pain. The parietal peritoneum contains somatic pain fibers that are sensitized via inflammatory cytokines, thereby generating localized, piercing pain. Pain sensations are sent to thoracolumbar spinal cord segments that directly correlate to areas within the abdominal cavity.[2] Understanding somatosensory pathways can help explain why patients with severe inflammatory disease, such as pancreatitis or peritonitis, clinically appear more uncomfortable than do animals with obstructive gastrointestinal (GI) problems or organ enlargement.

INITIAL ASSESSMENT

Patients with acute abdomen often present with significant cardiovascular abnormalities. A quick assessment for shock is mandatory. Clinical signs of shock depend on the cause and time frame. For example, clinical signs of early compensatory shock include tachycardia, normal mucous membrane color, rapid capillary refill time (CRT), and bounding pulses. Early in septic shock, clinical signs may be hyperdynamic, with rapid CRT and brick-red mucous membranes; as decompensation occurs, signs may include pale mucous membranes, prolonged CRT, weak peripheral pulses, and depres-

sion. This type of shock can be seen in patients with pyometra. However, septic cats present very differently and are often bradycardic and hypothermic, with pale mucous membranes and prolonged CRTs.[3]

Asking owners appropriate questions regarding patient history can be one of the most valuable diagnostic tools available when presented with a case of acute abdomen. First and foremost: What made the client bring in the pet? It is important to find out what clinical signs, if any, the animal has been exhibiting and obtain a general idea of the patient's activities. Inquiries should be made regarding the animal's everyday habits, including urination, defecation, appetite, and thirst. Has the animal been in contact with other animals? Are any other animals in the household sick? Has the animal had a full series of vaccinations? Abnormalities, such as vomiting, diarrhea, difficulty breathing, and coughing, should be described in detail by the owner. Specific questions should be asked pertaining to the color, the texture, and even the smell of vomitus or abnormal feces. Has there been blood in the vomitus/feces? How long has the animal been acting sick? The answers to these questions could prompt clinicians to highly suspect a more specific cause of illness (see the box on page 351). For example, if projectile vomiting begins suddenly, upper GI obstruction might be high on the list of diagnostic differentials. Dark, tarry feces should prompt clinicians to suspect GI bleeding. It is also important to ask whether the animal has had previous episodes of similar clinical signs. Has there been exposure to toxic substances? Does the pet chew on toys or other objects/substances? A systematic list of questions should be posed in every case of acute abdomen so that critical pieces of information are not missed.

Knowing the age, sex, and breed of the animal is beneficial when deciphering possible causes of acute abdomen. For example, large, deep-chested dogs are predisposed to developing GDV or splenic torsion.[1] However, puppies may be more likely to have parvoviral enteritis, intussusception, or a foreign body. An intact female that had a heat cycle 2 months ago and now presents with acute abdominal disease is a strong candidate for developing pyometra or other uterine abnormalities. Cases of dietary indiscretion or toxicities are often not related to age, breed, or gender.

PHYSICAL EXAMINATION

Initial Assessment

Because of the complex nature of acute abdomen, it is important to perform a detailed and systematic physical examination. An abbreviated physical examination may be required, depending on the patient's stability or need for immediate medical intervention. Following an initial assessment, periodic reevaluations are necessary. The animal's posture and gait should be visually inspected because abnormalities may be suggestive of abdominal pain. Animals that stand with an arched posture or that assume a "praying" position are often attempting to relieve discomfort.[4–7] A patient with overall weakness or spinal injury may present in lateral recumbency.[8] Some patients with nonspecific visceral pain may pace or appear restless.[3] In addition, abdominal pain may manifest simply as a reluctance to move, a stilted gait, tensing when the affected area is palpated, vocalization, tachypnea, or ptyalism due to nausea.[4]

Abdominal evaluation of animals that present with clinical signs of acute abdomen should include visual inspection, auscultation, percussion, rectal examination, and palpation.

Dehydration can be subjectively estimated by evaluating the patient's skin turgor and mucous membrane dryness. Skin turgor can be assessed by tenting the skin over the midlumbar area. Dry oral mucous membranes and eyes that appear dry and retracted into their sockets indicate severe dehydration. These tests are subjective and can be difficult to assess if a patient has lost weight and body fat. The mouth should be thoroughly examined for abnormalities such as linear foreign bodies, icteric mucous membranes, petechial hemorrhage, and evidence of ingestion of caustic substances.[2]

Abdominal Examination

Abdominal evaluation is the most important aspect of the physical examination. The abdomen should ideally

be palpated last to avoid inadvertently neglecting serious extraabdominal abnormalities.[4] In addition, abdominal palpation may elicit pain, thus preventing further examination. A complete abdominal examination consists of visual inspection, auscultation, percussion, rectal examination, and palpation.

Visual Inspection

The abdomen should be visually inspected for signs of distention. Abdominal trauma should be suspected if there is blood on surrounding fur. Shaving the area may uncover evidence of petechial hemorrhage, icterus, penetrating wounds, or swelling. These findings may reveal clues about the underlying condition. For example, a reddened umbilical region may indicate hemoabdomen. The inguinal and perineal regions should be visually inspected for irritation and discoloration, which can be signs of urinary tract compromise.[6]

Auscultation, Percussion, and Rectal Examination

The abdomen should be auscultated for evidence of bowel sounds. Absent bowel sounds may be suggestive of ileus, peritonitis, chronic obstruction, or abdominal fluid. Increased borborygmi may indicate acute enteritis or acute obstruction. Percussion involves gently "pinging" the abdominal wall between the thumb and forefinger while auscultating with a stethoscope. Dull sounds can be heard when the thumb and forefinger tap over a solid organ, whereas high-pitched sounds can be heard with gas-filled, hollow organs. Rectal examination is important to evaluate the prostate, urethra, pelvic inlet, and sublumbar lymph nodes as well as fecal character.[4]

Palpation

Superficial palpation can be a very valuable diagnostic tool in patients with acute abdomen and should be performed before attempting deep palpation. Gentle palpation can help identify pain and compromise in the abdominal wall. Deep palpation can be used to differentiate localized and generalized pain. Localizing pain to a particular region can help focus the examination on a particular organ or organ system. For example, pain elicited in the right cranial quadrant may indicate pancreatitis, whereas midabdominal pain may be suggestive of pathology involving the kidneys, bowel, or spleen.[6] A diagnosis of lower urinary tract obstruction can often be made based on caudal abdominal palpation and presence of a firm, distended urinary bladder. Deep palpation can identify other abnormalities such as organomegaly, organ displacement, masses (e.g., intussusception, tumor, foreign body), or the presence of fluid. A fluid "wave" can often be elicited with abdominal ballottement.

DIAGNOSTICS

Abdominal radiography is a standard tool used to evaluate most patients with acute abdomen. Other valuable imaging modalities include contrast radiography and ultrasonography. Because of the critical status of many patients with acute abdomen, survey radiographs are important to obtain for quick diagnostic information. Radiographs can give valuable information about whether surgical intervention is warranted. Conditions readily diagnosed on survey films include GDV, organomegaly, masses, obstruction, foreign body, free gas, effusion, calculi (i.e., renal, ureteral, or cystic), and body wall or diaphragmatic herniation.

Because of the rapid breathing pattern of many patients with acute abdomen, a short x-ray exposure time is recommended.[8] Two views (i.e., lateral and ventrodorsal) are preferred; however, a patient's clinical status may dictate positioning and the number of radiographs taken. The ventrodorsal view is favored because patients are usually stretched out, resulting in less tissue to penetrate.[8] Positioning becomes more important with certain conditions, such as GDV, in which a right lateral radiograph is the view of choice. Hanging lateral and horizontal beam views become beneficial when looking for free fluid or gas.

Survey abdominal radiography is extremely important, but ultrasonography and contrast radiography are also valuable.

On survey, extraabdominal structures should be evaluated first. Spinal pain may often present like abdominal pain; therefore, it is important to look for evidence of intervertebral disk disease, diskospondylitis, and other skeletal conditions. The abdominal wall and retroperi-

toneal space should be evaluated next. Loss of retroperitoneal detail may be suggestive of hemorrhage or urine leakage, whereas the presence of retroperitoneal gas can be secondary to pneumomediastinum or the result of a punctured or ruptured viscus or emphysematous cystitis.[9] Radiographic signs consistent with blunt trauma include herniation of organs into the thoracic cavity. Fluid of any type, including intraabdominal hemorrhage from blunt trauma, urine, and septic and nonseptic effusion, is characterized by decreased abdominal detail. Small pockets of fluid can occasionally be visualized on survey radiographs; however, ultrasound is much more sensitive, allowing detection of quantities as small as 4 ml/kg.[10]

Free abdominal gas is significant. The most common causes of pneumoperitoneum are penetration of the abdominal cavity (as a result of trauma or recent laparotomy), GI perforation, emphysematous cystitis, and ruptured hepatobiliary abscess or urinary bladder.[9] A thorough history allows differentiation of the cause. Free abdominal gas rises to the highest point; thus an animal can be positioned to enhance identification of small gas pockets. Placing an animal in dorsal recumbency and taking a horizontally directed view is a very sensitive technique. This positioning allows accumulation of gas between the liver, diaphragm, and ventral abdominal wall.[9]

The abdomen should also be evaluated for organomegaly or mass effects, which displace normal structures. Hepatomegaly is characterized by caudal deviation of the stomach axis. A large tubular structure located between the urinary bladder and colon in a female patient may be suggestive of pyometra. Prostatic enlargement causes cranial displacement of the urinary bladder and dorsal displacement of the colon. Splenomegaly and renomegaly may also be found on survey radiographs. Differentials for splenomegaly include neoplasia, hematoma, and torsion.[7] The medical history should be considered because administering certain drugs such as thiobarbiturates may also result in splenic enlargement. Kidneys that exceed 2.5 to 3.5 times (in dogs) or 2.4 to 3 times (in cats) the length of the second lumbar vertebra on a ventrodorsal view are considered enlarged. Diagnostic differentials for renomegaly include neoplasia, abscesses, cysts, edema, inflammation, hydronephrosis, and intracapsular hemorrhage.

Survey radiography is often used to diagnose other common causes of acute abdomen, such as GI obstruction and linear foreign bodies (Figure 1). Radiographic changes visible with obstruction include segmental dilation of bowel loops and stacking of distended loops with characteristic hairpin turns. Linear foreign bodies are often diagnosed based on evidence of intestinal plication and C-shaped gas patterns on survey films. As a general rule, the small bowel diameter in dogs should not exceed the height of the central portion of the body of a lumbar vertebra or twice the width of a rib, whereas, in cats, the diameter should not exceed twice the height of the central part of the fourth lumbar vertebra.[9] When the entire length of bowel is dilated and appears enlarged, a diagnosis of mesenteric torsion or volvulus must be considered.

Other conditions such as pancreatitis have more subtle radiographic changes; thus additional diagnostic testing is often required for definitive diagnosis. Several changes that can be associated with pancreatitis include localized loss of detail in the right cranial quadrant of the abdomen, persistent gas in the descending duodenum, calcification due to fat saponification,

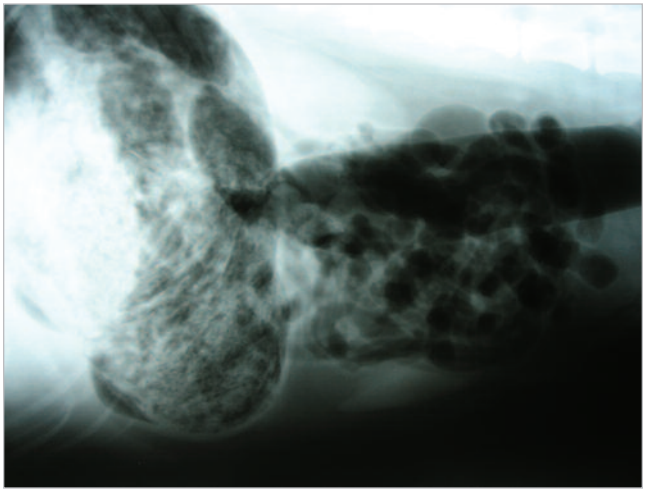

Figure 1. Radiograph showing a distended colon and large amount of foreign material that is impacting the stomach. During surgery, the foreign material was revealed to be 5 lb (2.3 kg) of ivy.

Figure 2. Radiograph of a barium series in which barium abruptly stops because of a nylon bone wedged in the intestine.

and a widened gastroduodenal angle. However, it is not recommended to diagnose pancreatitis based on these radiographic findings alone.

Various contrast studies may be helpful in diagnosing conditions that are equivocal on survey films (Figure 2). Such studies are particularly valuable in outlining abnormalities of the GI and urogenital systems. For an upper GI study, a barium dose of approximately 10 to 15 ml/kg is recommended. Rapid administration via a stomach tube can be beneficial because it can help determine transit time more accurately.[8] If GI perforation is suspected, using an organic iodide contrast medium is recommended because it is less irritating than barium should leakage into the peritoneal space occur. GI contrast studies can help determine whether transit time is prolonged or accelerated; however, there is a wide range of normal values. In general, barium should be cleared from the small bowel in 5 hours in dogs and 3 hours in cats.[9] Hypermotility can be secondary to increased intestinal contents (as with diarrhea) and conditions such as acute enteritis and peritonitis.[11]

Care should be taken to ensure that an adequate volume of barium is administered because this can greatly influence transit time through the GI tract.

Diaphragmatic hernia is always a concern with abdominal trauma. Positive-contrast peritoneography can be used to identify loss of diaphragmatic integrity. To use this technique, 1 ml/kg of a triiodinated contrast medium should be injected into the peritoneal space to help visualize the outline of the diaphragm.[9] Presence of contrast material in the pleural space and irregularity of the margin of the diaphragm are often diagnostic for diaphragmatic hernia.[9]

Contrast studies can also be used to assess the kidneys, ureters, and urinary bladder (Figure 3). These

Ideally, a complete blood cell count, chemistry screen, urinalysis, and coagulation panel should be submitted after stabilization and before volume replacement.

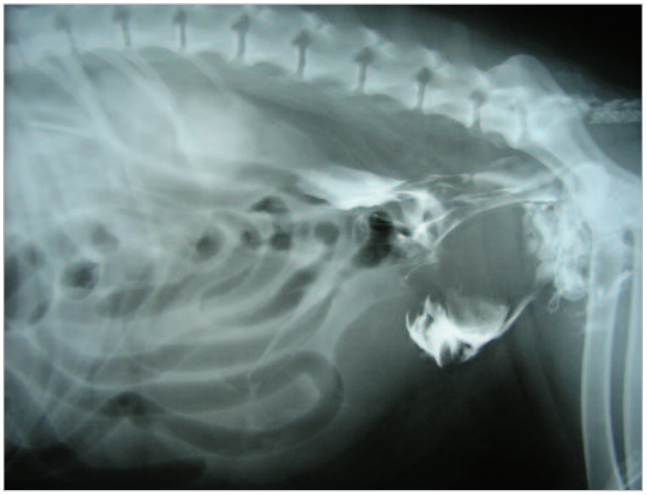

Figure 3. Radiograph of a contrast study in which iodinated material leaks into the peritoneal cavity from a tear in the bladder neck. The dog had been hit by a car 2 days earlier.

studies are particularly valuable when looking for ruptures or tears within the urinary system. Positive-contrast cystography is the procedure of choice to demonstrate bladder tears or ruptures.[9] To conduct this contrast study, the bladder should be evacuated and a 20% organic iodide compound injected through a urethral catheter.[9] Mucosal abnormalities and filling defects such as calculi may be better visualized by using double-contrast cystography. Urethral integrity can be assessed using contrast urethrography. It is recommended to use a balloon-tipped catheter (to prevent reflux of the medium) to inject 10 to 15 ml (in dogs) or 5 to 10 ml (in cats) of an organic iodide contrast medium.[9,12]

Ultrasonography can be very valuable in cases of acute abdomen and often leads to a definitive diagnosis. Ultrasonography is noninvasive; can help to specifically characterize abdominal organs; and can be particularly useful when looking at the hepatobiliary system, pancreas, urinary tract, GI tract, reproductive system, and retroperitoneal space. It can facilitate collection of abdominal fluid and help guide fine-needle aspiration of abdominal structures. When looking at the liver and other abdominal organs, it is important to note their relative echogenicity and homogenicity. A difference in echogenicity may be suggestive of tissue pathology. Discussing the ultrasonographic findings of all potential causes of acute abdomen is beyond the scope of this article; however, several conditions are relatively common and readily diagnosed with ultrasonography. For example, presence of a dilated gallbladder and common bile duct may be suggestive of biliary tract obstruction.[13–15] Ultrasonic findings consistent with pancreatitis include an enlarged and hypoechoic pancreas as well as free fluid within the abdomen. In addition, there may be evidence of hyperechoic peripancreatic tissue and extrahepatic biliary obstruction.[13,16–17] Ultrasonography is useful when looking for evidence of nephritis as well as radiolucent and radiopaque calculi associated with the urinary system.[18–20] Conditions associated with the reproductive tract that should also be considered include pyometra and prostatitis.[21–25]

CLINICAL PATHOLOGY

Once a patient with acute abdomen has been initially stabilized, laboratory tests should be submitted as soon as possible. Ideally, a full chemistry panel, including obtaining pancreatic amylase and lipase levels (if pancreatitis is suspected); a complete blood cell count; electrolyte analysis; urinalysis; and a coagulation panel should be evaluated before volume replacement. Although not 100% sensitive or specific, elevations in amylase and lipase can assist in diagnosing pancreatitis in some cases. This collection of tests can help determine whether underlying disease processes are present, including renal failure, coagulopathy, biliary dysfunction, and urinary tract trauma. The leukogram, complete with a manual differential count and morphologic description of the cells, can help determine whether inflammatory or infectious diseases are present.[1] Presence of toxic changes or a left shift can also help determine the severity of inflammation or infection. The hematocrit can be used to determine whether anemia is present, keeping in mind that the erythrocyte volume

When indicated, abdominocentesis and diagnostic peritoneal lavage may be the most specific and helpful tests in making a diagnosis.

can appear artifactually elevated or normal despite anemia when splenic contraction occurs. Evidence of regeneration may be present in cases of chronic anemia, whereas acute blood loss or anemia in chronic disease does not produce evidence of regeneration. Hypoproteinemia could warrant investigation of sources of hemorrhage or other exterior protein losses. Unless pyometra is suspected, a urine sample collected via cystocentesis helps evaluate whether glucosuria, bacteruria, pyuria, or hematuria are present. Urine specific gravity can also be used to evaluate renal function and concentrating ability.[6] Evidence of hypoglycemia may support the presence of septicemia in some patients. Aggressive IV antibiotic therapy would therefore be warranted after collecting blood and peritoneal fluid samples for bacterial culture and susceptibility testing. Other considerations in cases with low serum glucose values include pancreatic or hepatic neoplasia.

If a clinician does not have access to a full laboratory, several necessary values can be obtained even with minimal diagnostic capabilities. A manually obtained packed cell volume (PCV), total protein concentration, blood glucose level, urine specific gravity, blood urea nitrogen level, and activated clotting time as well as a peripheral blood smear to assess platelet count provide much-needed information about the immediate status of a critically ill patient. Abdominocentesis with fluid analysis and cytology can also be conducted and provides helpful clues about the cause of intraabdominal pathology.

Investigation into the presence of or predisposition for disseminated intravascular coagulopathy (DIC) is also essential in critical patients. Thrombocytopenia may be secondary to sequestration of platelets in the liver or spleen, DIC, increased platelet use resulting from hemorrhage, or decreased platelet production. A coagulation panel that measures prothrombin time, activated partial thromboplastin time, and fibrin degradation products can help rule out development of DIC.[1]

Once baseline blood and urine samples have been submitted and the patient has been triaged and stabilized, more in-depth diagnostics should be conducted. Arterial blood gas should be analyzed to determine the oxygenation and ventilatory status of the animal if respiratory compromise is suspected. Blood gas measurements are also helpful in determining the origin of tachypnea, if present. An elevated respiratory rate could be attributed to pain if oxygen content, alveolar to arterial oxygen gradient, and carbon dioxide levels of an arterial blood sample are normal. If oxygenation is low, however, the probability of impaired oxygen exchange in the lungs is increased. If respiratory status is normal, a jugular venous blood gas analysis can easily be obtained with little stress to the patient and can be used to assess acid–base status. Lactic acidosis can develop as a result of decreased tissue perfusion secondary to hypovolemia, further compromising patient stability. Metabolic alkalosis can also develop as a result of loss of hydrochloric acid in cases of pyloric obstruction.

Following diagnostic imaging modalities, diagnostic peritoneal lavage should be performed in cases of acute abdomen. Collecting cells within the peritoneal cavity can help determine whether hemoabdomen, biliary rupture, leakage of urine into the abdomen, pancreatic inflammation, and/or bacterial peritonitis are present. The information collected via diagnostic peritoneal lavage can help clinicians decide between medical and surgical treatment.[1]

Figure 4. To increase the chance of retrieving fluid from an effusive abdominal cavity, four separate quadrants must often be tapped.

ABDOMINOCENTESIS AND DIAGNOSTIC PERITONEAL LAVAGE

Abdominal fluid retrieval is a quick and highly specific diagnostic method used to determine the clinical status of a patient. If the amount of fluid in the peritoneal cavity is significant (5 to 25 ml/kg or more), abdominocentesis usually results in adequate sample collection.[7] If only small amounts of fluid are present, however, diagnostic peritoneal lavage may be necessary to investigate the character of the effusion. Indications for performing either procedure include decreased radiographic detail of the abdomen, blunt or penetrating trauma that may have entered the peritoneal cavity, clinical signs of shock without a diagnosed cause, and suspected dehisced, surgically repaired, hollow viscous.[7]

To increase the chance of retrieving fluid from an effusive abdominal cavity, tapping four separate quadrants is often required (Figure 4). The ventral abdomen should be surgically scrubbed before a tap. Four 20-gauge needles can be used to enter each quadrant of the peritoneal cavity. The four quadrants can be determined by visualizing a line at the level of the umbilicus to divide the abdomen into cranial and caudal halves and by using the ventral midline to divide the two halves into left and right components. A needle should be inserted into the central portion of each of these four quadrants.[7] As the needles are inserted through the skin, loops of intestines should tend to move away from the needle hub, thus making the procedure relatively risk free.[10] The needles should be left in place with no attachments for a couple of minutes to allow the capillary action of the needle to draw out fluid. If no material collects in the hub during this time, a syringe can be used to apply negative pressure to draw out effusive material.[10] It should be kept in mind that radiographs taken after abdominocentesis may show free air in the abdomen (i.e., pneumoperitoneum) that is not part of the underlying abdominal pathology. Therefore, radiographs should always be obtained before four-quadrant paracentesis. False-negative results occur more than half of the time, making the sensitivity of an abdominal tap fairly low.[2] If a clinician still thinks that peritoneal fluid collection would be beneficial but using centesis is unsuccessful in obtaining a sample, diagnostic peritoneal lavage or ultrasound-guided centesis should be used. Although this technique is not as simple to use as four-quadrant paracentesis, it is more than 90% accurate.

Diagnostic peritoneal lavage produces false-negative results less than 5% of the time. Cases that may produce false-negative results include trauma such as retroperitoneal injury and diaphragmatic hernia.[6] Peritoneal lavage is highly beneficial to clinicians when deciding whether to pursue surgery or medical management in a patient with acute abdomen. If diagnostic peritoneal lavage produces a negative result but the clinician still suspects infection or inflammation, it may be necessary to repeat diagnostic peritoneal lavage several hours later because results can change rapidly.

To perform diagnostic peritoneal lavage, the patient should be dorsally recumbent. The urinary bladder should be emptied with either catheterization or manual expression. The ventral abdomen should be surgically clipped and scrubbed. The ventral abdominal midline should be locally anesthetized using 2% lidocaine (2 mg/kg). The local block should begin 1 to 2 cm caudal

to the umbilicus and extend a few centimeters. If necessary, a 2% solution can be diluted to a 1% solution to extend the volume. An incision should then be made to dissect the skin, subcutaneous tissues, and superficial abdominal fascia.[6] Care should be taken to prevent iatrogenic hemorrhage into the peritoneal space, which would produce false results suggestive of hemoabdomen.

A fenestrated catheter (Argyle Trocar Thoracic Catheter, Kendall, Tyco Healthcare, Mansfield, MA) should be placed into the abdominal incision and directed caudodorsally until all the holes in the catheter are within the peritoneal cavity. If no fluid is collected by simple catheter placement and rolling the patient, warm 0.9% saline or lactated Ringer's solution (10 ml/lb[26]) should be infused into the abdominal cavity. The animal should then be gently rolled from side to side to distribute the saline throughout the peritoneal space. The fluid can then be collected by attaching an extension set to an empty fluid bag and allowing gravity to retrieve the infused fluid. Aspiration can be attempted if gravity alone does not collect a significant volume. If the fluid is red or pink, the extension set should be detached, the catheter capped, and a sample taken to determine the PCV. A PCV above 2% to 5% warrants a second retrieval approximately 30 minutes later to determine whether ongoing hemorrhage is present. The PCV should be determined again to compare it with that of the first sample. The catheter can be left in place for up to 3 hours.[6]

The fluid should be analyzed promptly after collection. If degenerate neutrophils, organic fibers, bacteria, or more than 2,000 leukocytes/µl are observed microscopically, surgery is needed immediately.[2] If bacteria are not observed, but septic abdomen is still suspected, the following test results would be suggestive of bacterial colonization in the peritoneal cavity[10,27]:

- Glucose concentration: <50 mg/dl
- pH: <7.2
- Partial pressure of carbon dioxide: >55 mm Hg
- Partial pressure of oxygen: <50 mm Hg
- Lactate concentration: >5.5 mmol/L

The presence of erythrocytes in the fluid is consistent with abdominal trauma. If the animal is in shock, therapy should be initiated promptly. If necessary, a blood transfusion should be administered. Only after these attempts fail to stabilize the patient should surgery be considered an immediate need. Placing pressure wraps around the abdomen may help control intraabdominal hemorrhage. However, caution must be taken when diaphragmatic hernia is suspected. Increased intraabdominal pressure can further compress the thoracic cavity, causing increased respiratory difficulty.[2] Another option that has been described for hemorrhage control is instilling fluid into the peritoneal cavity. This procedure can help control hemostasis by increasing pressure around leaking vessels or organs.

Creatinine level should also be evaluated on fluid collected by abdominal paracentesis. Peritoneal creatinine and potassium levels may be elevated compared with systemic creatinine levels in cases of urinary tract trauma not restricted to the retroperitoneal space.[28] Bilirubin level is another useful chemical marker in cases of biliary tract rupture. Pathognomonic signs of biliary tract leakage include a peritoneal bilirubin concentration that is greater than that in serum and/or the presence of green bilirubin crystals in peritoneal fluid. Presence of amylase in abdominal fluid collected via paracentesis is also useful in cases of suspected pancreatitis or bowel ischemia.

SUMMARY

When patients present with acute abdomen, clinicians must promptly determine the cause and whether to pursue medical or surgical treatment. This article outlines a com-

plete series of diagnostics that can guide clinicians through a thorough examination, including laboratory evaluation and more in-depth procedures such as diagnostic imaging, abdominocentesis, and diagnostic peritoneal lavage.

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ARTICLE #2 CE TEST

This article qualifies for 1.5 contact hours of continuing education credit from the Auburn University College of Veterinary Medicine. Subscribers who wish to apply this credit to fulfill state relicensure requirements should consult their respective state authorities regarding the applicability of this program. To participate, fill out the test form inserted at the end of this issue. To take the CE test online, log on to ***www.VetLearn.com****.*

1. Absent bowel sounds are not suggestive of

a. abdominal fluid.
b. chronic obstruction.
c. acute obstruction.
d. peritonitis.
e. ileus.

2. What aspect of an abdominal evaluation should be performed last?

a. rectal examination
b. percussion
c. visual inspection
d. auscultation
e. palpation

3. Which of the following conditions cannot be readily diagnosed on survey abdominal films?

a. pancreatitis
b. GDV
c. pneumoperitoneum
d. linear foreign body
e. mesenteric torsion

4. In a tachypneic patient with a normal arterial oxygen content and alveolar–arterial gradient, an elevated respiratory rate would most likely be due to

a. metabolic acidosis.
b. respiratory alkalosis.
c. pain.
d. hypoxemia.
e. pulmonary edema.

5. Which of the following is not necessary to determine when evaluating fluid from the peritoneal space?

a. alanine aminotransferase concentration
b. prothrombin time

c. blood urea nitrogen level
d. amylase concentration
e. PCV

6. The most appropriate therapy for a patient with uroabdomen, azotemia, and metabolic acidosis would be
a. inserting a urinary catheter.
b. peritoneal drainage and observation.
c. immediate surgical repair.
d. medical therapy until stabilization and then surgery.
e. applying an abdominal pressure bandage.

7. Which of the following conditions should be considered an immediate surgical emergency?
a. pneumoperitoneum
b. lower intestinal obstruction/foreign body
c. pancreatitis
d. open pyometra
e. acute intraabdominal hemorrhage secondary to blunt trauma

8. Clinical signs of acute abdomen and a reddened area around a patient's umbilicus would be suggestive of
a. petechial hemorrhage.
b. rodenticide intoxication.
c. *Staphylococcus* spp pyoderma.
d. abdominal hemorrhage.
e. none of the above

9. When looking for free fluid in the abdomen, which radiographic view is favored?
a. lateral
b. ventrodorsal
c. dorsoventral
d. horizontal or hanging lateral
e. orthogonal

10. A dog presents 1 week after being treated at another facility for being hit by a car. The patient has signs of severe abdominal pain. Abdominocentesis reveals green crystals in the neutrophils. The most likely diagnosis would be
a. traumatic pancreatitis.
b. digested hemoglobin from intraabdominal hemorrhage.
c. biliary tract damage.
d. ingesta from ruptured stomach.
e. uroabdomen.